BINARY NUMBERING: THE LANGUAGE OF COMPUTERS

(estimated instructional time: 50 minutes)

Grade Level: 7-8

Objectives:

In this activity the students will master the following tasks:

- Recognize the positions in a binary number and know the value of each position.
- Using pencil and paper, convert simple binary numbers and decimal numbers.
- Using a calculator, determine if answers are correct.

Overview:

This activity is designed to assist students in their quest to master the binary numbering system. Upon completion, the pupils will convert binary numbers to decimal numbers. Computers and networking equipment such as bridges, switches and routers work with binary numbers, a series of bits that is either on (represented as binary 1) or off (represented as binary 0). Binary is encrypted internally in a personal computer and on networking media as either electrical voltage on copper cable or as pulses of light on fiber optic cable. Generally speaking, people have difficulty working with binary numbers because of the length. Therefore, binary numbers, with to regard to computers, are converted into decimal numbers making them more identifiable.

Materials:

1. Paper and Pencil
2. Binary Worksheet (provided by the instructor)
3. Calculator

Part One: Decimal Numbers

Overview: Students are familiar with decimal numbers (base 10) and should understand that this particular numbering system is based on the powers of 10. Upon completion, students will have developed an understanding of the exponentiation or powers on numbers using the base 10 numbering system, which is what our arithmetic and money system is based on. With base 10, the right-most position has a value of 1. Each position moving to the left is worth 10 times more. 10 to the zero power (10^0) is 1, 10 to the first power (10^1) is 10, 10 to the second power (10^2) is 100, 10 to the third power (10^3) is 1,000 and so on. Remember, multiply the number in each position times the value of each position (example: $600 = 6 \times 10^2$ or 6×100). Finally, remind the students that any number to the zero power is always 1!

Example: Decimal Number Conversion

The chart below shows how the decimal number system represents the number **234,657**. This will help in understanding the binary numbering system.

Exponents	10^6	10^5	10^4	10^3	10^2	10^1	10^0
Position	7	6	5	4	3	2	1
Value	1,000,000	100,000	10,000	1,000	100	10	1
Number	**0**	**2**	**3**	**4**	**6**	**5**	**7**
	0 x 1,000,000	2 x 100,000	3 x 10,000	4 x 1,000	6 x 100	5 x 10	1 x 1

Part Two: Binary Numbers

Overview: The binary numbering system is based on the powers of 2. This activity will help student's understanding of exponentiation or powers of numbers using the base 2 number system. Which is what all computers and data communications use. With base 2, the right-most position has a value of 1, as with base ten. Each position moving to the left is worth two times more. 2 to the zero power (2^0) is 1, 2 to the first power (2^1), 2 to the second power (2^2) is 4, two to the third power (2^3) is 8, and so on. Just multiply the number in each position, a zero or one times the value of each position (example: 8= 1 x 2^3 or 1 x 8) and add up the total. Remember, any number to the zero power is 1. Convert the following binary numbers to decimal numbers.

Example: Binary Number Conversion

The following chart shows the detail calculations, starting from the right side, to convert the binary number **10011100** into a decimal number.

Exponents	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
Position	8	7	6	5	4	3	2	1
Value	128	64	32	16	8	4	2	1
Bit Status	**1**	**0**	**0**	**1**	**1**	**1**	**0**	**0**
	128			16	8	4		

Notice how the each column with a binary number has the value written underneath.
Now simply add the values together and this will determine the decimal equivalent to the designated binary (128+16+8+4=156 or 156=**10011100** in binary)

Procedures:

1. The teacher will discuss the different kinds of problems that parallel computers can be utilized to solve (monitoring the nuclear weapons stockpile, computer-generated graphics, predicting weather patterns, code breaking, analysis of geographical data, research in galaxy formations, etc.).
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2. The teacher will provide a practice sheet of conversion problems that will prepare them for the code-breaking activity. (Suggested presentation methods: chalkboard, overhead projector, individual white boards) This will provide the students with an opportunity to practice binary conversions before application to decipher a code.
3. The students will be working in cooperative groups of two after given the necessary instructions facilitated by the instructor.
4. The objective of the lesson will be to convert binary numbers into decimal numbers. After completing the conversion, the decimal number will be matched with the letter equivalent.
5. The students will, given the designated worksheet, place the letter with the corresponding space to spell out a message.
6. Time permitting, the pupils will check all work with a calculator.

Desired Outcome/Results

The activity is designed to show how messages can be sent across a medium (CAT5, Fiber Optic, Wireless) in the form of pulses of light or electricity, represented by binary 1 or binary 0. The students should be able to spell out the rudimentary message using the conversion techniques introduced by the instructor.